

## THE AUSTRALIAN GERMPLASM OF PINK FLOWERING SERRADELLA SPECIES

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*Summary.* Recent introductions into Australia of germplasm of *Ornithopus isthmocarpus*, *O. ?perpusillus* and *O. sativus* were evaluated with germplasm already held in genetic resource collections. Preliminary assessment revealed that the new material expanded the genetic diversity in agronomically important characters such as flowering time, seed size and hardseededness. Analysis of the passport data gives a guide to the likely range of adaptation of the species. The increased diversity identified within *O. sativus* justifies ongoing research directed at producing commercial cultivars.

### INTRODUCTION

The genus *Ornithopus* is endemic to the Mediterranean and south western Europe (6). French or pink serradella (*O. sativus* Brot) is native in south western France, the northern half of the Iberian peninsula and Acores. It is cultivated as a fodder plant in much of Europe where it has become naturalised. Birdsfoot serradella (*O. perpusillus* L.) occurs in western and west central Europe extending eastwards to Italy, Poland and southern Sweden. Moroccan serradella (*O. ?isthmocarpus* Coss.) occurs in the south western part of the Iberian peninsula and Morocco. Several intermediate species or types formed by natural crosses have been identified (5).

Most of the germplasm of French and birdsfoot serradellas was introduced into Australia between 1950 to 1953 and 1987 to 1988. With the exception of two accessions, germplasm of *O. ?isthmocarpus* was introduced in recent times by Australian collectors (3, 4). Data was first reported from field plantings at Kelmscott (1) and later at Esperance (2). Further development of the species did not proceed due to their poor persistence relative to yellow serradella.

Recent introductions of germplasm, a serious commitment to funding genetic resource activities, and a need to identify species for changing farming systems gave rise to this study. This report summarises the site data of collected germplasm, and compares the preliminary agronomic data of germplasm held before 1987 with that of recently introduced germplasm.

### MATERIALS AND METHODS

Site data of collected germplasm, or passport data, was obtained from the Plant Introduction Centre, CSIRO Canberra, or extracted from published or unpublished collection reports.

Germplasm was grown at the Medina research station and at South Perth between 1991 and 1993. Material was grown as single spaced plants and sown in the first week of May. Plants grew without nutrient or water limitations. They were scored as flowering when the corolla first became visible. Growth habit was assessed using a visual rating scale. Stem thickness was measured physically. In 1993 three stems were selected at random from a single flowering plant and measured half way along its length with a micrometer. Pods were harvested and cleaned using sieves and aspiration to provide harvest weights. Seed weight was measured on duplicate samples of twenty five seeds. Seed colour and shape were assessed visually on the 50 seeds extracted for weighing. Initial hardseed per cent was assessed on four replicates of 100 pod segments subjected to 7 days in an alternating temperature cabinet (diurnal cycle from 15 to 60°C). Seed softening was assessed as above by treating separate pod samples for periods of approximately 1, 2, 4, or 6 months. Germinated seeds and hardseeds were counted after being on germination paper for 21 days at 15°C.

### RESULTS

*Passport data*

Characteristics of the sixteen sites from which *O. isthmocarpus* was collected are associated with annual rainfall between 300 and 715 mm, low altitude, and acid sandy soils (Table 1). Characteristics of the eight sites from which *O. perpusillus* was collected are associated with an altitude of between 100 and 762 m, and mostly acid sandy soils. Other pasture legume species associated at the sites are also listed. Passport data exists for only two of the thirty four introductions of *O. sativus*.

Table 1. Passport data of accessions of *O. isthmocarpus* and *O. perpusillus*.

Accession	Origin	Rainfall (mm)	Altitude (m)	Soil type	Soil pH	Associated species
<i>O. isthmocarpus</i>						
65306	Morocco	550	50	red brown fine loamy sand	acid	l oc mt
65307	Morocco	500	100	sand	acid	oc op ts
65308	Morocco	525	50	brown loamy sand	acid	l mt ts
65309	Morocco	590	50	red silty sand	acid	l mt ah
128585	Morocco	-	-	sandy loam	-	-
MCD112	Morocco	300	200	light brown sand	8.5	lm
MCD113	Morocco	300	200	dark grey loam	7	mi mp s oc
MCD43	Morocco	600	20	light brown sand	7	mt ts tc oc op
14440	Portugal	-	-	grey sand	-	-
48802	Portugal	-	-	sand	neutral	op oc
44708	Spain	715	100	yellow sand over red clay	-	-
SEF21	Spain	550	175	sand	6.5	ts ta oc la
SEF24	Spain	550	20	sand	6.3	op
SEF25	Spain	550	20	sand	7	tc tt op b ml

SEF26	Spain	550	10	loamy sand	6.8	tc op b mt
SEF34	Spain	400	210	loamy sand	5.8	oc tc ta l
O. perpusillus						
49292	France	-	-	sand	-	-
65302	Morocco	550	100	red brown loamy sand	neutral	l mt
134572	Portugal	-	750	-	5	-
137405	Portugal	-	350	pale brown gritty sand	5.8	op oc
68027	Spain	800	400	brown silty sand	acid	la
134558	Spain	-	700	-	5.5	-
137406	Spain	-	762	gritty grey sand	5.8	lh oc
137407	Spain	-	716	fine brown sand	5.8	oc t

ah *Astragalus hamosus*; b *Bisserula* sp.; l *Lupinus* sp.; la *L. angustifolius*; lh??*L. ?hispanicus*; lm??*L. ?micranthus*; mi *M. intertexta*; ml *M. litteralis*; mp??*M. ?polymorpha*; mt *Medicago tornata*; oc??*Ornithopus compressus*; op *O. pinnatus*; s??*Scorpiurus* sp.; t *Trifolium* sp.; ta??*T. ?angustifolium*; tc??*T. ?cherleri*; ts *T. subterraneum*; tt *T. tomentosum*.

#### Preliminary agronomic data

Germplasm of *O. isthmocarpus* introduced since 1989 extends the range of flowering time, particularly in material from Spain (Table 2). Plants are more prostrate and finer stemmed than those of the older germplasm. Seeds are yellow and flat, and are distinct from seed of the other species in that they are tapered at their ends (Table 3). Seeds range considerably in their hardness, and in nearly two thirds of accessions hardseeds do not soften with the treatments imposed. There is considerable variation in seed weight between accessions from 1.2 to 2.6?mg.

Table 2. Range in flowering time, pod yield, growth habit and stem thickness.

Species/year introduced	Accessions name or number/origin	Flowering time (days)	Pod yield (g/plant)	Growth habit <sup>#</sup>	Mean stem thickness (mm)
O. isthmocarpus					

Prior to 1987	8	119-145	177-391	p-se	3.4-4.7
1989	12 (Morocco)	114-138	134-330	p	1.9-3.0
1991	21 (Spain)	110-165	108-417	p	2.4-3.4
<i>O. perpusillus</i>					
Prior to 1987	GM34 (CPI 65302)	122-132	229	p	3.0
1989	3 (Spain, Portugal)	143-170	37-125	p	2.1-2.3
<i>O. sativus</i>					
Prior to 1987	25	134-153	326-398*	e-se*	3.9-4.0*
1991	ZAF5 (South Africa)	116-145	350	se	3.9
1991	5 (South Africa)	140-172	43-419	e-ve	3.3-3.7
1992	Grasslands Koha	144-178	147	se	4.1
1992	Emena	128-142	382	se	3.7
Evaluated 1991	246 (WA naturalised)	95-169	6-250	p-e	-

# p - prostrate; e - erect; se - semi erect.

\* Data for the two surviving accessions.

Recent introductions of *O. perpusillus* are late maturing, prostrate, fine stemmed, and poor yielding (Table 2). They have very small seeds which soften readily (Table 3). GM34 flowers much earlier than the European accessions and has slightly larger seeds which do not soften.

Table 3. Range in seed weight, colour, shape, hardness and softening response.

Species/ accession	Weight (mg)	Colour	Shape	Initial hard seed (%)	Accession number Softening response
<i>O. isthmocarpus</i>	1.2-2.6	yellow	flat, pointed	30-99	8(+), 15(0), 1(-)

## *O. perpusillus*

Post 1988	0.8-1.0	yellow	round	52-93	3(+)
GM34	1.2	yellow	round	89	1(0)

## *O. sativus*

Prior to 1987 and current varieties	2.3-3.0	yellow, brown	flat, round	0-1.0	-
Post 1990	3.3-3.6	yellow, brown	flat, round	65-68	3(+)
WA naturalised	1.4-2.5	yellow	round	0-84	11(+), 1(0), 8(-)

Softening response- (+) = seeds soften; (-) = seeds harden; (0) = no change in hardseed per cent.

Recent introductions of *O. sativus* are both later and much earlier flowering than material held before 1987 (Table 2). Western Australian naturalised accessions differ by virtue of their large range in pod yield and growth habit as well as their early flowering. Accessions introduced prior to 1987 and current varieties are soft seeded (Table 3). Recent introductions possess seeds with a wider range in weight, and seeds that are hard initially and either soften, harden or don't change. The hardening of seeds in one naturalised accession is associated with a decline in seed moisture content from 8.4% to 3.3%, thereafter seeds begin to soften (R. Snowball, unpubl. data).

## DISCUSSION

Evaluation of two accessions of *O. isthmocarpus* prior to 1968 lead to the opinion that the species was agronomically inferior (1). Two other accessions tested in 1981 and 1982 gave only an average performance (2). Germplasm collected since 1987 is earlier maturing and probably more grazing tolerant through its prostrate habit than older material, and therefore better suited to the medium to high rainfall zone of the Western Australian wheatbelt. The hardseeded nature of the material should ensure persistence between periods of cropping. There is a high level of aluminium tolerance among some accessions which would be an advantage on the acid, wadjil soils (B. Nutt, pers. commun.). The recent development of a dehulling machine will overcome low initial establishment also encountered with podded, yellow serradella.

A taxonomic study by the author indicates that GM34 is closest to *O. sativus*, however considering it originated from Morocco it may be a new species. While GM34 may have some potential in mid season areas, the genuine accessions of *O. perpusillus* are unlikely to be of use except on very poor, acid soils in long season growing areas. An old accession (CPI 32013) performed very well in earlier trials (1), but no seed exists as a result of inadequate conservation. The small size of this collection warrants the further exploration for germplasm.

Germplasm of *O. sativus* introduced before 1987 probably represents cultivated forms of the species, exhibiting soft seeded and late maturing characteristics. Consequently it is unsuitable for most parts of Australia where serradella is adapted. It is not clear if *O. sativus* that is naturalised in Europe persists as a result of hardseeds, but it is likely that this plays some role in the persistence of the material naturalised at Esperance. The hardseededness and early maturity in some of the new material provides a valuable

opportunity for the development of this species. Some of the material is currently being tested for suitability to a pasture/crop system on acid, sandy soils in the medium rainfall zone of the Western Australian wheatbelt. This system involves short periods of pasture (3-5 years) between similar periods of cropping designed to overcome the problem of herbicide resistant grass weeds. The upright habit and aerial seeding nature of the species would provide a relatively easy and cheap source of seed for resowing, while some hardseededness would couple short term persistence with high plant densities early in the pasture phase.

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